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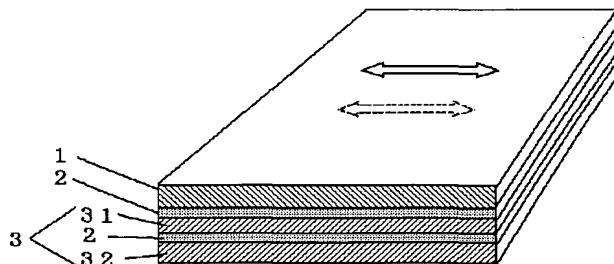
(54)【発明の名称】 広視野偏光板

(57)【要約】

【課題】 液晶表示装置における良視認領域を拡大できる偏光層を得ること。

【解決手段】 偏光層(1)の片側に、遅相軸方向の屈折率を n_s 、進相軸方向の屈折率を n_t 、厚さ方向の屈折率を n_z 、層厚をdとして、式： $(n_s - n_z) / d$ で定義される厚さ方向位相差が300nm以下で、式： $(n_s - n_t) / d$ で定義される面内位相差が20nm以下の複屈折層A(31)と、当該面内位相差が50~200nmで、式： $(n_s - n_z) / (n_s - n_t)$ で定義される N_z が0.8~3.5の複屈折層B(32)とを有し、かつその複屈折層Bの遅相軸と前記偏光層の透過軸とが平行関係又は直交関係にある広視野偏光板。

【効果】 偏光層面に垂直な正面方向では輝度やコントラストの低下を防止でき、かつ液晶セルの複屈折性による直線偏光の状態変化を補償して、着色化等の色変化や階調反転がなくてコントラストや明るさに優れる良視認性の領域を拡大でき、視角範囲の広い液晶表示装置が得られる。



【特許請求の範囲】

【請求項1】 偏光層の片側に、遅相軸方向の屈折率を n_s 、進相軸方向の屈折率を n_f 、厚さ方向の屈折率を n_z 、層厚をdとして、式： $(n_s - n_z) / d$ で定義される厚さ方向位相差が300nm以下で、式： $(n_s - n_f) / d$ で定義される面内位相差が20nm以下の複屈折層Aと、当該面内位相差が50～200nmで、式： $(n_s - n_z) / (n_s - n_f)$ で定義される N_z が0.8～3.5の複屈折層Bとを有し、かつその複屈折層Bの遅相軸と前記偏光層の透過軸とが平行関係又は直交関係にあることを特徴とする広視野偏光板。

【請求項2】 請求項1において、複屈折層Aが偏光層の透明保護層を兼ねるものである広視野偏光板。

【請求項3】 請求項1又は2において、複屈折層A、複屈折層B及び偏光層の一部又は全部が高分子フィルムからなる広視野偏光板。

【請求項4】 請求項1～3において、複屈折層Aがトリアセチルセルロースからなる広視野偏光板。

【請求項5】 請求項1～4に記載の広視野偏光板を液晶セルの少なくとも片側に有することを特徴とする液晶表示装置。

【発明の詳細な説明】

【0001】

【発明の技術分野】 本発明は、良視認の視角範囲が広い液晶表示装置を形成しうる広視野偏光板に関する。

【0002】

【従来の技術】 低電圧、低消費電力でIC回路と直結でき、表示機能が多様で軽量性等に優れるなどの多くの特長に着目されてワードプロセッサやパーソナルコンピュータ等のOA機器やテレビジョン、カーナビゲーションモニタや航空機コックピット用モニタなどの種々の表示手段として液晶表示装置が広く普及しているが、CRTに比べて良視認の視角範囲の狭さが指摘されて久しい。

【0003】 前記視角範囲の狭さは、液晶に特有の光学的異方性が視認性の視野角特性に影響して、偏光層を介して液晶セルに入射した直線偏光が梢円偏光化したり、方位角が変化することに原因があると考えられている。すなわち、液晶セルを透過した当該偏光状態の表示光をそのまま視認側の偏光層に入射させると、視野角すなわち正面（垂直）方向を基準とした見る角度の増大に伴い透過率が低下して表示明度が不足したり、階調が反転したり、着色化等の色変化を生じるなどの視認性の低下を招くものと考えられている。

【0004】 従来、液晶表示装置の良視認領域の拡大方法、すなわち視角範囲の拡大方法としては、位相差板を用いる方法が知られており、その位相差板として種々のものが提案されている（特開平4-229828号公報、特開平4-258923号公報、特開平6-75116号公報、特開平6-174920号公報、特開平6-22213号公報）。しかしながらいずれの場合にも、良

視認の視角範囲の拡大性の点で改善効果に乏しく満足できるものではなかった。

【0005】

【発明の技術的課題】 本発明は、液晶セルに対して配置する偏光層を改善することにより、液晶表示装置における良視認領域を拡大することを課題とする。

【0006】

【課題の解決手段】 本発明は、偏光層の片側に、遅相軸方向の屈折率を n_s 、進相軸方向の屈折率を n_f 、厚さ方向の屈折率を n_z 、層厚をdとして、式： $(n_s - n_z) / d$ で定義される厚さ方向位相差が300nm以下で、式： $(n_s - n_f) / d$ で定義される面内位相差が20nm以下の複屈折層Aと、当該面内位相差が50～200nmで、式： $(n_s - n_z) / (n_s - n_f)$ で定義される N_z が0.8～3.5の複屈折層Bとを有し、かつその複屈折層Bの遅相軸と前記偏光層の透過軸とが平行関係又は直交関係にあることを特徴とする広視野偏光板を提供するものである。

【0007】

【発明の効果】 複屈折層Aと複屈折層Bからなる重疊複屈折層を偏光層の片側に配置し、かつ偏光層の透過軸と複屈折層Bの遅相軸を平行関係又は直交関係とした上記の構成により、偏光層面に垂直な正面方向では各複屈折層の位相差の影響を受けずに輝度やコントラストの低下を防止でき、かつ複屈折層A、Bを介し液晶セルの複屈折性による直線偏光の状態変化を補償して、着色化等の色変化や階調反転がなくてコントラストや明るさに優れる良視認性の領域を拡大でき、視角範囲の広い液晶表示装置を得ることができる。

【0008】

【発明の実施形態】 本発明の広視野偏光板は、偏光層の片側に、遅相軸方向の屈折率を n_s 、進相軸方向の屈折率を n_f 、厚さ方向の屈折率を n_z 、層厚をdとして、式： $(n_s - n_z) / d$ で定義される厚さ方向位相差が300nm以下で、式： $(n_s - n_f) / d$ で定義される面内位相差が20nm以下の複屈折層Aと、当該面内位相差が50～200nmで、式： $(n_s - n_z) / (n_s - n_f)$ で定義される N_z が0.8～3.5の複屈折層Bとを有し、かつその複屈折層Bの遅相軸と前記偏光層の透過軸とが平行関係又は直交関係にあるものである。その例を図1、図2に示した。1が偏光層、3が複屈折層A 3 1と複屈折層B 3 2からなる重疊複屈折層であり、矢印が透過軸、遅相軸の方向を表している。なお2は、接着剤層である。

【0009】 偏光層としては、所定の偏光状態の光を得ることができる適宜なものを用いうる。就中、直線偏光状態の透過光を得ることのできるものが好ましい。その例としては、ポリビニルアルコール系フィルムや部分ホルマール化ポリビニルアルコール系フィルム、エチレン・酢酸ビニル共重合体系部分ケン化フィルムの如き親水

性高分子フィルムにヨウ素及び／又は二色性染料を吸着させて延伸したもの、ポリビニルアルコールの脱水処理物やポリ塩化ビニルの脱塩酸処理物の如きポリエン配向フィルム等からなる偏光フィルムなどがあげられる。

【0010】偏光層、就中、偏光フィルムは、その片側又は両側に透明保護層を有するものであってもよい。その場合、透明保護層に所定の複屈折特性を示すものを用いて本発明における複屈折層A又はBを兼ねさせることもできる。また偏光層は、反射層を有する反射型のものであってもよい。反射型の偏光層は、視認側（表示側）からの入射光を反射させて表示するタイプの液晶表示装置などを形成するためのものであり、バックライト等の光源の内蔵を省略できて液晶表示装置の薄型化をはかりやすいなどの利点を有する。

【0011】透明保護層は、プラスチックの塗布層や保護フィルムの積層物などとして適宜に形成でき、その形成には透明性や機械的強度、熱安定性や水分遮蔽性等に優れるプラスチックなどが好ましく用いられる。その例としては、ポリエステル系樹脂やアセテート系樹脂、ポリエーテルスルホン系樹脂やポリカーボネート系樹脂、ポリアミド系樹脂やポリイミド系樹脂、ポリオレフィン系樹脂やアクリル系樹脂、あるいはアクリル系やウレタン系、アクリルウレタン系やエポキシ系やシリコーン系等の熱硬化型、ないし紫外線硬化型の樹脂などがあげられる。透明保護層は、微粒子の含有によりその表面が微細凹凸構造に形成されていてもよい。

【0012】反射型偏光層の形成は、必要に応じ透明樹脂層等を介して偏光層の片面に金属等からなる反射層を付設する方式などの適宜な方式で行うことができる。その具体例としては、必要に応じマット処理した保護フィルム等の透明樹脂層の片面に、アルミニウム等の反射性金属からなる箔や蒸着膜を付設したものや、前記透明樹脂層の微粒子含有による表面微細凹凸構造の上に蒸着方式やメッキ方式などの適宜な方式で金属反射層を付設したものなどがあげられる。

【0013】複屈折層A、Bとしては、複屈折による所定の位相差等を示す適宜なものを用いよう。就中、光透過性の各種フィルムを延伸処理等により複屈折性を付与したものや、液晶ポリマーの配向膜、あるいは基材の配向膜上等に液晶ポリマー等の異方性材料を配向させたものなどが好ましく用いられる。特に、光透過率が70%以上、好ましくは80%以上、より好ましくは85%以上の透過性に優れるフィルムに複屈折性を付与したもののが好ましい。

【0014】前記の透光性フィルムとしては、ポリカーボネートやポリアリレート、ポリスルホンやポリエチレンテレフタレート、ポリエーテルスルホンやポリビニルアルコール、ポリエチレンないしポリプロピレンの如きポリオレフィンやトリアセチルセルロースの如きセルロース系ポリマー、ポリスチレンやポリメチルメタクリレ

ート、ポリ塩化ビニルやポリ塩化ビニリデン、ポリアミドなどからなるフィルムが特に好ましい。

【0015】透光性フィルムに複屈折性を付与する配向処理は、例えば自由端又は固定端による一軸延伸処理や二軸延伸処理などの適宜な方式で行うことができる。本発明にては、厚さ方向に配向したフィルムや、その厚さ方向の主屈折率の方向がフィルムの法線方向に対して傾斜したものなども複屈折層の形成に用いられる。延伸方式や延伸条件等の配向処理条件の制御、形成材料の変更などにより複屈折による位相差特性を調節でき、本発明に用いられる複屈折層を形成することができる。また本発明で用いる複屈折層A、Bは、複数の位相差板を積層して所定の位相差特性を示すように形成されたものであってもよい。

【0016】本発明において偏光層の片側に配置する複屈折層は、複屈折層Aと複屈折層Bの重疊複屈折層にて形成され、その複屈折層Aは、厚さ方向位相差が300nm以下で面内位相差が20nm以下のものとされる。また複屈折層Bは、面内位相差が50~200nmでN_zが0.8~3.5のものとされ、かつ複屈折層Bはその遅相軸が偏光層の透過軸と平行関係又は直交関係となるように配置される。なお前記の厚さ方向位相差は、遅相軸方向の屈折率をn_s、進相軸方向の屈折率をn_t、厚さ方向の屈折率をn_z、層厚をdとして、式：(n_s-n_z)dで定義される。また面内位相差(△nd)は、式：(n_s-n_t)dで定義され、N_zは、式：(n_s-n_z)/(n_s-n_t)で定義される。各屈折率は、ナトリウムD線に基づく。

【0017】前記において、偏光層の透過軸に対する複屈折層Bの遅相軸の平行関係又は直交関係による配置は、上記したように正面方向における各複屈折層の位相差の影響を防止して輝度やコントラストの低下の回避を目的とする。また複屈折層の重疊化は、前記の平行又は直交関係の配置状態において、視角が正面方向よりズレた場合に複屈折層Bの遅相軸方向が変化して当該平行関係又は直交関係にズレが生じ、そのズレ量に応じて複屈折層の光学異方性が発現することから、複屈折層A及び複屈折層Bの面内位相差とN_zに基づいて前記した遅相軸の変化量を制御し、複屈折層における光学異方性の発現量の調節を目的とする。

【0018】すなわち前記は、複屈折層Bの面内位相差とN_zを最適化しつつ、面内位相差が可及的に少ない複屈折層Aを介して厚さ方向位相差を制御することが良視認の視角範囲拡大に有利であることを意味する。良視認の視角範囲拡大の点より好ましい複屈折層Aは、面内位相差が18nm以下、就中15nm以下、特に0~10nmで、厚さ方向位相差が250nm以下、就中220nm以下、特に30~200nmのものである。面内位相差が20nmを超える複屈折層A、又は厚さ方向位相差が300nmを超える複屈折層Aでは、前記した遅相軸変化の制御

性に乏しくて良視認の視角範囲の拡大力に乏しくなる。

【0019】また良視認の視角範囲拡大の点より好ましい複屈折層Bは、面内位相差が60～190nm、就中80～170nm、特に100～140nmで、N_dが3.3以下、就中3.0以下、特に2.8以下のものである。その面内位相差が50nm未満では視角の変化に対する補償効果に乏しい場合があり、200nmを超えると複屈折率差の波長分散で着色化等の色変化を生じる場合がある。またN_dが0.8未満や3.5を超える値では、視角による遅相軸の変化が大きくなつて補償できる視角範囲が狭くなり、広視野角化が困難となる。

【0020】偏光層に対する複屈折層A、Bの配置順序は任意であるが、得られる広視野偏光板の薄型化等の点よりは、図例の如く複屈折層A31を偏光層側として偏光層1の透明保護層を兼ねさせたものが好ましい。その場合、複屈折層Aの形成には位相差特性等の点よりトリアセチルセルロースフィルムが特に好ましく用いられる。なお複屈折層A、Bの厚さは、上記の如く面内位相差と関係することから目的とする位相差特性などにより適宜に決定できるが、一般には5～500μm、就中10～350μm、特に20～200μmとされる。

【0021】本発明の広視野偏光板は、液晶セルの複屈折による視角特性の補償に好ましく用いられるが、その形成は液晶表示装置の製造過程で複屈折層A、Bと偏光層を順次別個に積層する方式や、予め複屈折層Aと複屈折層Bと偏光層の適宜な組合せからなる2層又は3層の積層物としてそれを用いる方式などの適宜な方式で行うことができる。後者の事前積層化方式が、品質の安定性や積層作業性等に優れて液晶表示装置の製造効率を向上させうる利点などがある。

【0022】偏光層の片側への複屈折層Bの積層配置等に際しては、その偏光層の透過軸と複屈折層Bの遅相軸とが平行関係又は直交関係となるように行われるが、その平行関係又は直交関係は厳密な意味での平行又は直交状態に限定されず、作業上の配置誤差などは許容される。また透過軸や遅相軸の方向にバラツキがある場合には全体としての平均方向に基づいて平行関係又は直交関係に配置される。

【0023】上記において、偏光層と複屈折層A、Bの積層に際しては、必要に応じ接着剤等を介して固定することができる。軸関係のズレ防止等の点よりは接着固定することが好ましい。接着には、例えばアクリル系やシリコーン系、ポリエステル系やポリウレタン系、ポリエーテル系やゴム系等の透明な感圧接着剤などの適宜な接着剤を用いることができ、その種類については特に限定はない。光学特性の変化を防止する点などよりは、硬化や乾燥の際に高温のプロセスを要しないものが好ましく、長時間の硬化処理や乾燥時間を要しないものが望ましい。また加熱や加湿条件下に剥離等を生じないものが好ましい。

【0024】かかる点より、(メタ)アクリル酸ブチルや(メタ)アクリル酸メチル、(メタ)アクリル酸エチルや(メタ)アクリル酸の如きモノマーを成分とする重量平均分子量が10万以上で、ガラス転移温度が0℃以下のアクリル系ポリマーからなるアクリル系感圧接着剤が特に好ましく用いられる。またアクリル系感圧接着剤は、透明性や耐候性や耐熱性などに優れる点よりも好ましい。なお屈折率が異なるものを積層する場合には、反射損の抑制などの点より中間の屈折率を有する接着剤等が好ましく用いられる。

【0025】接着剤には、必要に応じて例えば天然物や合成物の樹脂類、ガラス纖維やガラスピース、金属粉やその他の無機粉末等からなる充填剤や顔料、着色剤や酸化防止剤などの適宜な添加剤を配合することもできる。また微粒子を含有させて光拡散性を示す接着剤層としてもできる。

【0026】なお上記した偏光層や複屈折層A、B、透明保護層や接着剤層などの各層は、例えばサリチル酸エステル系化合物やベンゾフェノール系化合物、ベンゾトリシアゾール系化合物やシアノアクリレート系化合物、ニッケル錯塩系化合物等の紫外線吸収剤で処理する方式などにより紫外線吸収能をもたせることもできる。

【0027】本発明の広視野偏光板を用いての液晶表示装置の形成は、従来に準じて行いられる。すなわち液晶表示装置は一般に、液晶セルと偏光層と光学補償を目的とした複屈折層、及び必要に応じての照明システム等の構成部品を適宜に組立てて駆動回路を組むことなどにより形成されるが、本発明においては当該広視野偏光板を液晶セルの少なくとも片側に設ける点を除いて特に限定ではなく、従来に準じうる。

【0028】従って、液晶セルの片側又は両側に広視野偏光板を配置した液晶表示装置や、照明システムにバックライトあるいは反射板を用いたものなどの適宜な液晶表示装置を形成することができる。その場合、複屈折層A、Bは液晶セルと偏光層との間、特に視認側の偏光層との間に配置することが補償効果の点などより好ましい。なお広視野偏光板の実用に際しては、液晶表示装置を形成するための他の光学素子等との積層物などの適宜な形態で用いることができる。

【0029】図3、図4に広視野偏光板を用いた液晶表示装置の構成例を示した。4が液晶セル、5がバックライトシステム、6が反射層である。なお7は光拡散板である。図3のものは両側に広視野偏光板を配置したバックライト型照明システムのものであり、図4のものは片側にのみ広視野偏光板を配置した反射型照明システムのものである。

【0030】前記において液晶表示装置の形成部品は、積層一体化状態又は適宜な分離状態にあってよい。また液晶表示装置の形成に際しては、例えば拡散板やアンチグレア層、反射防止膜、保護層や保護板などの適宜な光

学素子を適宜に配置することができる。本発明の広視野偏光板は、TN型やSTN型等の複屈折を示す液晶セルを用いたTFT型やMIM型等の種々の表示装置に好ましく用いられる。

【0031】

【実施例】

実施例1

厚さ80μmのポリビニルアルコールフィルムをヨウ素水溶液中で5倍に延伸処理したのち乾燥させて得た偏光フィルムの片面に、厚さ15μmのポリビニルアルコール系接着剤層を介して、トリアセチルセルロースフィルムの二軸延伸物からなる△nd:6nm(Nz:1.0)、厚さ方向位相差60nmの複屈折フィルムAを接着し、かつその上に厚さ20μmのアクリル系接着層を介して、厚さ60μmのポリカーボネートフィルムを160℃の雰囲気下、周速の異なるロール間を通過させて1.15倍に延伸処理して得た△nd:350nm、Nz:1.0のものを用いたほかは、実施例1に準じて偏光板を得た。

【0032】実施例2

複屈折フィルムBとして、厚さ60μmのポリカーボネートフィルムを160℃の雰囲気下、二軸延伸処理して得た△nd:80nm、Nz:2.0のものを用いたほかは、実施例1に準じて広視野偏光板を得た。

【0033】比較例1

実施例1に準じて得た偏光フィルムのみを用いた。

【0034】比較例2

複屈折フィルムAの外側に、アクリル系接着層と複屈折フィルムBを有しない形態としたほかは、実施例1に準

じて偏光板を得た。

【0035】比較例3

複屈折フィルムAを用いずに、偏光フィルムと複屈折フィルムBをアクリル系接着層を介して直接接着したほかは、実施例1に準じて偏光板を得た。

【0036】比較例4

複屈折フィルムBとして、厚さ60μmのポリカーボネートフィルムを160℃の雰囲気下、周速の異なるロール間を通過させて1.15倍に延伸処理して得た△nd:350nm、Nz:1.0のものを用いたほかは、実施例1に準じて偏光板を得た。

【0037】比較例5

複屈折フィルムBとして、厚さ60μmのポリカーボネートフィルムを160℃の雰囲気下、周速の異なるロール間を通過させて1.03倍に延伸処理して得た△nd:40nm、Nz:1.0のものを用いたほかは、実施例1に準じて偏光板を得た。

【0038】比較例6

複屈折フィルムAとして、厚さ60μmのポリカーボネートフィルムを160℃の雰囲気下に二軸延伸処理して得た△nd:20nm、厚さ方向位相差350nmのものを用いたほかは、実施例1に準じて偏光板を得た。

【0039】評価試験

実施例、比較例で得た(広視野)偏光板をTFT型液晶セルの両側(フロント/リア)に配置し、黒つぶれ(表示の黒色化)や白抜け(表示の白色化)によるコントラストの低下及び階調の反転を生じない良視認を示す左右方向及び上下方向の視角範囲を調べた。

【0040】前記の結果を次表に示した。

	視角範囲(度)	
	左右方向	上下方向
実施例1	160	40
実施例2	160	70
比較例1	50	35
比較例2	60	30
比較例3	100	35
比較例4	40	25
比較例5	60	30
比較例6	80	45

【0041】表より、実施例と偏光フィルムのみの比較例1との対比より、左右の視角範囲が格段に改善されており、上下方向の視角範囲も若干改善されていることがわかる。また比較例2～6との対比より、所定の複屈折特性を満足する層を重畠化することが視角範囲の拡大に有利であることがわかる。なお実施例と比較例1における視認不良は、階調の反転による。

【図面の簡単な説明】

【図1】広視野偏光板例の部分断面斜視図

【図2】他の広視野偏光板例の部分断面斜視図

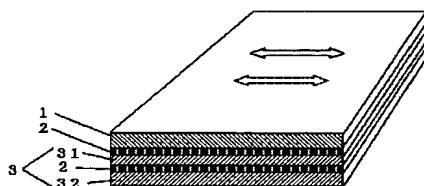
【図3】液晶表示装置例の断面図

【図4】他の液晶表示装置例の断面図

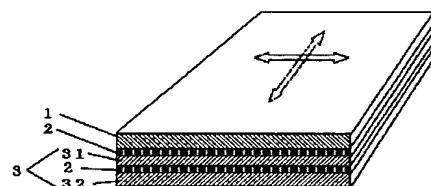
【符号の説明】

- 1：偏光層
- 2：接着剤層
- 3：重畠複屈折層
- 31：複屈折層A
- 32：複屈折層B
- 4：液晶セル

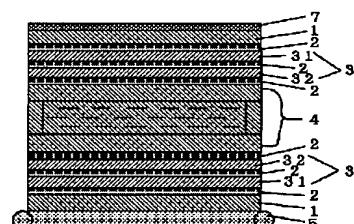
【図1】



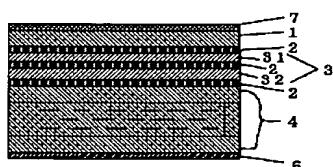
【図2】



【図3】



【図4】



フロントページの続き

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[Title of the Invention] Polarizing plate with wide viewing field

[Scope of Patent Claims]

[Claim 1]

A polarizing plate with wide viewing field forming a birefringence layer A having the phase difference in a thickness direction which is defined by a formula : $(n_s - n_z)d$ and is set to not more than 300 nm and the intra-plane phase difference which is defined by a formula : $(n_s - n_f)d$ and is set to not more than 20 nm and a birefringence layer B having the intra-plane phase difference which is set to 50 to 200 nm and N_z which is defined by a formula $(n_s - n_z) / (n_s - n_f)$ and is set to 0.8 to 3.5 on one side of a polarizing layer, wherein n_s indicates a refractive index in a lagging axis direction, n_f indicates a refractive index in a leading axis direction, n_z indicates a refractive index in a thickness direction and d indicates a layer thickness, and the lagging axis of the birefringence layer B and the transmission axis of the polarizing layer have either a relationship of being parallel to each other or a relationship of intersecting each other at a right angle.

[Claim 2]

A polarizing plate with wide viewing field according to claim 1, wherein the birefringence layer A is also used as a transparent protective layer of the polarizing layer.

[Claim 3]

A polarizing plate with wide viewing field according to claim 1 or 2, wherein a portion or the whole of the birefringence layer A, the birefringence layer B and the polarizing layer is formed of a polymer film.

[Claim 4]

A polarizing plate with wide viewing field according to claims 1 to 3, wherein the birefringence layer A is made of triacetylcellulose.

[Claim 5]

A liquid crystal display device having the polarizing plate with wide viewing field according to claims 1 to 4 formed on at least one side of a liquid crystal cell.

[Detailed Explanation of the Invention]

[0001]

[Technical Field to which the Invention pertains]

The present invention relates to a polarizing plate with wide viewing field which is capable of forming a liquid crystal display device having a large well-visible viewing angle range.

[0002]

[Prior Art]

A liquid crystal display device has attracted attentions due to its many characteristics such that the device can be directly connected to an IC circuit at a low voltage and with a low power consumption, has versatile display functions and is excellent in light-weight property or the like and hence,

the liquid crystal display device has been widely spread as various display means including an OA appliance such as a word processor or a personal computer, a television, a car navigation monitor, an airplane cockpit monitor and the like. However, so many years have passed since it was pointed out that the viewing angle range of good visibility is narrow compared to that of a CRT.

[0003]

It is considered that the narrowness of the viewing angle range is caused by a phenomenon that an optical anisotropy intrinsic to the liquid crystal influences the viewing angle characteristics of the visibility so that linear polarized light which is incident on the liquid crystal cell through the polarizing layer is converted into the elliptically polarized light or an azimuth angle is changed. That is, when the display light in the polarized state which has passed the liquid crystal cell is made to be directly incident on the viewing-side polarizing layer, corresponding to the increase of the viewing angle, that is, an angle as viewed using a front (vertical) direction as the reference, the transmittance is deteriorated thus bringing about the deterioration of the visibility such as the shortage of the display brightness, the inversion of the gray scale or the change of color such as coloring.

[0004]

Conventionally, as a method for enlarging the well-

visible region, that is, as a method for enlarging a viewing angle range of a liquid crystal display device, a method which uses a phase difference plate has been known and various plates have been proposed as such a phase difference plate (Japanese Patent Laid-Open No. 229828/1992, Japanese Laid-Open No. 258923/1992, Japanese Patent Laid-Open No. 75116/1994, Japanese Patent Laid-Open No. 174920/1994, Japanese Patent Laid-Open No. 222213/1994). However, any one of these plates fails to obtain a sufficient improvement effect with respect to the enlargement of the viewing angle having a favorable visibility.

[0005]

[Task to be solved by the Invention]

It is a task of the present invention to enlarge the well-visible range of a liquid crystal display device by improving a polarizing layer which is arranged with respect to a liquid crystal cell.

[0006]

[Means for solving the Task]

The present invention provides a polarizing plate with wide viewing field forming a birefringence layer A having the phase difference in a thickness direction which is defined by a formula: $(n_s - n_z)d$ and is set to not more than 300 nm and the intra-plane phase difference which is defined by a formula: $(n_s - n_f)d$ and is set to not more than 20 nm and a birefringence

layer B having the intra-plane phase difference which is set to 50 to 200 nm and N_z which is defined by a formula: $(n_s - n_z) / (n_s - n_f)$ and is set to 0.8 to 3.5 on one side of a polarizing layer, wherein n_s indicates a refractive index in a lagging axis direction, n_f indicates a refractive index in a leading axis direction, n_z indicates a refractive index in a thickness direction and d indicates a layer thickness, and the lagging axis of the birefringence layer B and the transmission axis of the polarizing layer have either a relationship of being parallel to each other or a relationship of intersecting each other at a right angle.

[0007]

[Effect of the Invention]

Due to the above-mentioned constitution which arranges a superposed birefringence layer consisting of the birefringence layer A and the birefringence layer B on one side of the polarizing layer and which makes the transmission axis of the polarizing layer and the lagging axis of the birefringence layer B have either a relationship of being parallel to each other or a relationship of intersecting each other at a right angle, the liquid crystal display device can prevent the deterioration of the brightness and the contrast without receiving the influence of the phase difference of respective birefringence layers in a front direction perpendicular to a surface of the polarizing layer, can enlarge

the region of well visibility which is free from the color change such as coloring or the like and the inversion of gray scale and exhibits the excellent contrast and brightness by compensating for the change of state of the linear polarization due to the birefringence of the liquid crystal cell through the birefringence layers A, B whereby a liquid crystal display device having a wide viewing angle can be obtained.

[0008]

[Mode for carrying out the Invention]

A polarizing plate with wide viewing field according to the present invention includes a birefringence layer A having phase difference in a thickness direction which is defined by a formula: $(n_s - n_z)d$ and is set to not more than 300 nm and the intra-plane phase difference which is defined by a formula: $(n_s - n_f)d$ and is set to not more than 20 nm and a birefringence layer B having the intra-plane phase difference which is set to 50 to 200 nm and N_z which is defined by a formula: $(n_s - n_z) / (n_s - n_f)$ and is set to 0.8 to 3.5 on one side of a polarizing layer, wherein n_s indicates a refractive index in a lagging axis direction, n_f indicates a refractive index in a leading axis direction, n_z indicates a refractive index in a thickness direction and d indicates a layer thickness, and the lagging axis of the birefringence layer B and the transmission axis of the polarizing layer have either a relationship of being parallel to each other or a relationship of intersecting each

other at a right angle. An example is shown in Fig. 1 and Fig. 2. Numeral 1 indicates a polarizing layer, numeral 3 indicates a superposed birefringence layer which consists of a birefringence layer A31 and a birefringence layer B32, and an arrow direction indicates the directions of the transmission axis and the lagging axis. Here, numeral 2 indicates an adhesive agent layer.

[0009]

As the polarizing layer, any suitable layer which can obtain a given polarized state can be used. Particularly, it is preferable to use a layer which can obtain the transmission light in the linear polarized state. As an example, a polarizing film which is produced in such a manner that iodine and/or dichromism dye is absorbed in a hydrophilic polymer film such as a polyvinylalcohol-based film, a partially-formal polyvinylalcohol-based film, an ethylene-vinylacetate copolymer-based partially saponified film and then the film is drawn, a polychloride oriented film such as a dehydrated polyvinylalcohol or a desalinated polyvinylchloride or the like is named.

[0010]

The polarizing layer, particularly the polarizing film, may be provided with a transparent protective layer on either one side or both sides thereof. In such a case, by using the transparent protective layer exhibiting given birefringence

characteristics, the layer may be used as either the birefringence layer A or B. Further, the polarizing layer may be of a reflection type which has a reflection layer. The reflection-type polarizing layer is served for forming a liquid crystal display device of a type which performs a display by reflecting incident light from the viewing side (display side). The reflection-type polarizing layer has advantages including an advantage that it becomes possible to omit the incorporation of a light source such as a backlight or the like so that the liquid crystal display device can be made thin.

[0011]

The transparent protective layer can be suitably formed as a laminated member which is made of a plastic coating layer and a protective film or the like. To form the transparent protective layer, plastic or the like which exhibits excellent properties with respect to the transparency, the mechanical strength, the thermal stability, the moisture shielding property and the like can be suitably used. As an example, polyester-based resin, acetate-based resin, polyethersulfone-based resin, polycarbonate-based resin, poliamide-based resin, polyimide-based resin, polyolefin-based resin, acrylic resin, or acrylic and urethane-based resin, acrylic urethane-based resin, epoxy-based resin, silicone-based thermosetting-type resin or ultraviolet-curing-type resin or the like can be named. The transparent protective

layer may be formed such that a surface thereof has a fine irregular structure by containing fine particles therein.

[0012]

The reflection-type polarizing layer may be formed by a suitable method such as a method in which the reflection layer made of metal or the like is adhered to one surface of the polarizing layer through a transparent resin layer or the like when necessary. As a specific example, a method which applies a foil or a vapor-deposited film made of a reflection film such as aluminum or the like onto one surface of the transparent resin layer such as a protective film or the like which is subjected to a mat finishing when necessary or a method which applies a metal reflection layer onto the fine irregular surface structure of the above-mentioned transparent resin layer containing fine particles using a vapor deposition method, a plating method or the like is named.

[0013]

As the birefringence layers A, B, any suitable layers which exhibit given phase differences or the like due to the birefringence can be used. Particularly, layers which are formed by giving the birefringence to various light-transmitting films by making the films subjected to the drawing treatment or the layers which orient anisotropic material such as liquid crystal polymer or the like on an orientation film of a liquid crystal polymer, or an orientation film of a

substrate can be preferably used. Particularly, It is preferable to use birefringence layers which are formed by giving the birefringence to films having the excellent transmittivity which exhibit the light transmittance of not less than 70 %, preferably not less than 80 %, more preferably not less than 85 %.

[0014]

As the above-mentioned light-transmitting film, a film made of polycarbonate, polyarylate, polysulfone, polyethylene terephthalate, polyether sulfone, polyvinyl alcohol, polyolefin such as polyethylene or polypropylene and cellulose-based polymer such as triacetylcellulose, polystyrene, polymethy-metha-acrylate, polyvinyl chloride and polyvinylidene chloride, polyimide or the like is particularly preferable.

[0015]

The orientation treatment for giving birefringence to the light transmitting film can be performed by a suitable method such as a uniaxial drawing treatment or a biaxial drawing treatment which is performed while holding ends of film in a free state or in a fixed state. In the present invention, a film which is oriented in a thickness direction or a film whose direction of the main refractive index is inclined with respect to a normal direction of the film or the like can be used. The phase difference characteristics due to the birefringence can

be adjusted by controlling the orientation treatment conditions such as the drawing method, the drawing condition or the like or by changing the forming material whereby the birefringence layer which can be served for the present invention can be formed. Further, the birefringence layers A, B which are used in the present invention may be formed by laminating a plurality of phase difference plates such that the birefringence layers A, B exhibit given phase difference characteristics.

[0016]

In the present invention, the birefringence layers which are arranged on one side of the polarizing layer are formed of the superposed birefringence layer consisting of the birefringence layer A and the birefringence layer B and the birefringence layer A has the phase difference in a thickness direction of not more than 300 nm and the intra-plane phase difference of not more than 20 nm. Further, the birefringence layer B has the intra-plane phase difference of 50 to 200 nm and N_z of 0.8 to 3.5 and the birefringence layer B is arranged such that the lagging axis thereof has either a parallel relationship or an orthogonal relationship with respect to the transmission axis of the polarizing layer. Here, assuming the refractive index in a lagging axis direction as n_s , the refractive index in a leading axis direction as n_f , the refractive index in a thickness direction as n_z , and the layer thickness as d , the above-mentioned phase difference in a

thickness direction can be defined by a formula : $(n_s - n_z)/d$. Further, the intra-plane phase difference (Δnd) is defined by a formula : $(n_s - n_f)d$ and Nz is defined by a formula : $(n_s - n_z)/(n_s - n_f)$. Respective refractive indices are based on the sodium D-line.

[0017]

In the above explanation, the arrangement of the lagging axis of the birefringence layer B in either the parallel relationship or the orthogonal relationship with respect to the transmission axis of the polarizing layer is provided for obviating the lowering of the brightness and the contrast by preventing the influence of the phase difference of respective birefringence layers in the above-mentioned front direction. Further, with respect to the superposition of the birefringence layers, in the arrangement state adopting either the parallel relationship or the orthogonal relationship, when the viewing angle is displaced from the front direction, the direction of the lagging axis direction of the birefringence layer B is changed thus giving rise to the displacement of the parallel relationship or the orthogonal relationship whereby the optical anisotropy of the birefringence layer is generated corresponding to a displacement quantity. Accordingly, by controlling a change quantity of the above-mentioned lagging layer based on the intra-plane phase difference and Nz of the birefringence layer A and the birefringence layer B, the

generation quantity of the optical anisotropy in the birefringence layers can be adjusted.

[0018]

That is, the above explanation implies that the control of the phase difference in a thickness direction through the birefringence layer A having the least intra-plane phase difference while optimizing the intra-plane phase difference and N_z of the birefringence layer B is advantageous for enlarging the viewing angle range having the well visibility. The preferable birefringence layer A from a viewpoint of enlarging the viewing angle range of well visibility is a layer which sets the intra-plane phase difference to not more than 18 nm, preferably to not more than 15 nm, and particularly 0 to 10 nm, the phase difference in the thickness direction to not more than 250 nm, preferably not more than 220 nm, and particularly to 30 to 200 nm. The birefringence layer A whose intra-plane phase difference exceeds 20 nm or the birefringence layer A whose phase difference in a thickness direction exceeds 300 nm suffers from the poor ability to control the above-mentioned change of the lagging axis and hence, the birefringence layer A suffers from the power to enlarge the viewing angle range of the well visibility.

[0019]

The preferable birefringence layer B from a viewpoint of enlarging the viewing angle range of well visibility is a layer

which sets the intra-plane phase difference to 60 to 190 nm, preferably to 80 to 170 nm, and particularly 100 to 140 nm and N_z to not more than 3.3, preferably not more than 3.0, and particularly not more than 2.8. When the intra-plane phase difference is less than 50 nm, the birefringence layer suffers from the poor compensation effect for the change of the viewing angle, while when the intra-plane phase difference exceeds 200 nm, there may arise a case in which the color change such as coloring or the like is generated due to the chromatic dispersion of the difference of birefringence. Further, when the value of N_z is less than 0.8 or exceeds 3.5, the change of the lagging axis due to the viewing angle becomes large and hence, the viewing angle range which can be compensated becomes narrow whereby it is difficult to obtain the wide viewing angle.

[0020]

Although the order of arrangement of the birefringence layers A, B with respect to the polarizing layer is arbitrary, from a viewpoint of making the polarizing plate having wide viewing field thin or the like, it is preferable to use the birefringence layer A31 shown in the drawing such that the birefringence layer A31 also works as a transparent protective layer of the polarizing layer 1 at the polarizing layer side. In this case, from a viewpoint of the phase difference characteristics and the like, it is particularly preferable to use an triacetylcellulose film to form the birefringence layer

A. Here, since the thickness of the birefringence layers A, B relates to the intra-plane phase difference as mentioned above, the thickness can be suitably determined based on the targeted phase difference characteristics. In general, however, the thickness is set to 5 to 500 μm , preferably 10 to 350 μm , and particularly to 20 to 200 μm .

[0021]

Although the polarizing plate having wide viewing field may be preferably used for the compensation of the viewing angle characteristics due the birefringence of the liquid crystal cell, the polarizing plate may be formed by a suitable method such as a method which separately laminates the birefringence layers A, B and the polarizing layer in sequence in the manufacturing process of the liquid crystal display device or a method which preliminarily prepares a two-layered or three-layered laminated product made of a suitable combination of the birefringence layer A, the birefringence layer B and the polarizing layer and uses such a laminated product. The latter pre-laminating method is more advantageous since the method exhibits the excellent stability of quality, the excellent laminating operability and other excellent properties so that the manufacturing efficiency of the liquid crystal display device can be enhanced.

[0022]

The lamination and the arrangement of the birefringence

layer B to one side of the polarizing layer is performed such that the transmission axis of the polarizing layer and the lagging axis of the birefringence layer B take the parallel relationship or the orthogonal relationship with each other. However, the parallel relationship or the orthogonal relationship is not limited to the parallel state or the orthogonal state in a strict meaning of the terms and hence, the arrangement errors in operation are allowed. Further, when there exist irregularities with respect to the directions of the transmission axis and the lagging axis, they are arranged in the parallel relationship or the orthogonal relationship based on the average directions as a whole.

[0023]

In the above explanation, in laminating the polarizing layer and the birefringence layers A, B, they can be fixed to each other by means of an adhesive agent when necessary. It is preferable to adopt the fixing by adhesion from a viewpoint of preventing the displacement of the axial relationship and the like. The adhesion may be performed using a suitable adhesive agent such as a transparent pressure-sensitive adhesive agent including an acrylic-based adhesive agent, a silicone-based agent, a polyester-based agent, a polyurethane-based agent, a polyether-based agent, a rubber-based agent or the like. The kind of the adhesive agent is not specifically limited. From a viewpoint of preventing

the change of optical characteristics, it is preferable to use the adhesive agent which requires no high temperature treatment at the time of hardening or drying and it is also preferable to use the adhesive agent which does not require the hardening treatment or the drying time performed for a long time. Further, it is preferable to use the adhesive agent which does not generate the peeling-off or the like under the heated or humidified condition.

[0024]

From the above-mentioned viewpoint, it is preferable to use an acrylic pressure-sensitive adhesive agent made of an acrylic polymer which includes monomer such as (metha) butyl acrylate, (metha) methyl acrylate, (metha) ethyl acrylate, (metha) acrylic acid and has the mean molecular weight of not less than 100,000 and glass transition temperature of not more than 0°C. Further, the acrylic pressure-sensitive adhesive agent is preferable from a viewpoint that the agent exhibits the excellent transparency, whetherability and heat resistance and the like. To laminate layers having different refractive indices, it is preferable to use an adhesive agent having an intermediate refractive index from a viewpoint of suppressing the reflection loss.

[0025]

Suitable additives such as a filler made of natural or synthetic resin or the like, glass fiber, glass beads, metal

powder, inorganic power or the like, pigment, a coloring agent or an oxidation prevention agent or the like, for example, is blended into the adhesive agent when necessary. Further, the adhesive agent may contain fine particles so as to form an adhesive agent layer which exhibits the light diffusing ability.

[0026]

The above-mentioned respective layers such as the polarizing layer, the birefringence layers A, B, the transparent protective layer, the adhesive agent layer or the like may have the ultraviolet ray absorption power by a method which processes these layers using an ultraviolet ray absorbent such as a salicyrylate ester-based compound, a benzophenol-based compound, a benzotriazole-based compound, a cyanoacrylate-based compound, a nickel complex salt-based compound or the like, for example.

[0027]

The formation of the liquid crystal display device using the polarizing plate having wide viewing field of the present invention is performed by substantially following the conventional manner. That is, the liquid crystal display device is, in general, formed by suitably assembling constituent parts such as the liquid crystal cell, the polarizing layer, the birefringence layers which are served for optical compensation and, when necessary, the illumination

system and the like and thereafter by incorporating a driving circuit. In this embodiment, there is no specific limitation except for a point that the polarizing plate having wide viewing field is mounted on at least one side of the liquid crystal cell and hence, the liquid crystal display device can be formed substantially in the conventional manner.

[0028]

Accordingly, a suitable liquid crystal display device such as a liquid crystal display device which arranges the polarizing plate having wide viewing field at one side or both sides of the liquid crystal cell or the liquid crystal display device which uses a backlight or a reflection plate as an illumination system can be formed. In this case, from a viewpoint of the compensation effect, it is preferable to arrange the birefringence layers A, B between the liquid crystal cell and the polarizing layer, and more particularly between the liquid crystal cell and the viewing-side polarizing layer. At the time of actually using the polarizing plate having wide viewing field, the polarizing plate can be used in a suitable mode in which the polarizing plate constitutes a laminated product together with other optical elements or the like for forming the liquid crystal display device.

[0029]

Fig. 3 and Fig. 4 show a constitutional example of the liquid crystal display device which uses the polarizing plate

having wide viewing field. Numeral 4 indicates the liquid cell, numeral 5 indicates a backlight system and numeral 6 indicates a reflection layer. Here, numeral 7 indicates a light diffusion plate. The liquid crystal display device shown in Fig. 3 is of a backlight-type illumination system which arranges polarizing plates having wide viewing field at both sides and the liquid crystal display device shown in Fig. 4 is of a reflection-type illumination system which arranges the polarizing plate having wide viewing field only at one side.

[0030]

In the above explanation, the constituent parts of the liquid crystal display device may be in a state that they are integrally laminated or in a state that they are suitably separated. Further, in forming the liquid crystal display device, suitable optical elements such as a diffusion plate, an anti-glare layer, a reflection prevention layer, a protective layer, a protective plate or the like may be suitably arranged. The polarizing plate having wide viewing field may be suitably used in various kinds of display devices such as a TFT type, a MIM type or the like which uses the liquid crystal cell exhibiting the birefringence of TN type or STN type.

[0031]

[Experiment]

Experiment 1

A polyvinylalcohol film having a thickness of 80 μm was

subjected to a drawing treatment at a drawing rate of 5 in an iodine aqueous solution and thereafter was dried to obtain a polarizing film. Onto one surface of the polarizing film, a birefringence film A being made of a biaxial drawing product of a triacetylcellulose film and having $\Delta n_d : 6 \text{ nm}$ ($N_z : 10$) and the phase difference in a thickness direction of 60 nm was adhered by way of a polyvinylalcohol-based adhesive layer having a thickness of 15 μm . Thereafter, onto the birefringence film A, a birefringence film B which has $\Delta n_d : 115 \text{ nm}$ and $N_z : 1.0$ and was obtained by making a polycarbonate film having a thickness of 60 μm drawn by 1.08 times using a drawing treatment in which the polycarbonate film was made to pass between rollers having different peripheral speeds under an atmosphere of 160 °C was adhered by way of an acrylic tacky adhesive layer having a thickness of 20 μm to obtain a polarizing plate having wide viewing field. Here, the adhesion treatment was performed such that the transmission axis of the polarizing film B and the lagging axis of the birefringence film are in the parallel relationship.

[0032] Experiment 2

Except for a point that a film which has $\Delta n_d : 80 \text{ nm}$ and $N_z : 2.0$ and was obtained by making a polycarbonate film having a thickness of 60 μm subjected to a biaxial drawing treatment under an atmosphere of 160 °C was used as the birefringence film B, the polarizing plate having wide viewing field was obtained

in the substantially same manner as the experiment 1.

[0033] Comparison Example 1

Only the polarizing film obtained in the substantially same manner as the experiment 1 was used.

[0034] Comparison Example 2

Except for a point that the acrylic tacky adhesive layer and the birefringence film B were not provided to an outside of the birefringence film A, the polarizing plate was obtained in the substantially same manner as the experiment 1.

[0035] Comparison Example 3

Except for a point that the polarizing film and the birefringence film B were directly adhered to each other by way of the acrylic tacky adhesive layer without using the birefringence film A, the polarizing plate was obtained in the substantially same manner as the experiment 1.

[0036] Comparison Example 4

Except for a point that a film which has $\Delta n_d : 350 \text{ nm}$ and $N_z : 1.0$ and was obtained by making a polycarbonate film having a thickness of $60 \mu\text{m}$ drawn by 1.15 times using a drawing treatment in which the polycarbonate film was made to pass the rollers having different peripheral speeds under an atmosphere of 160°C was used as the birefringence film B, the polarizing plate was obtained in the substantially same manner as the experiment 1.

[0037] Comparison Example 5

Except for a point that a film which has $\Delta n_d : 40$ nm and $N_z : 1.0$ and was obtained by making a polycarbonate film having a thickness of 60 μm drawn by 1.03 times using a drawing treatment in which the polycarbonate film was made to pass the rollers having different peripheral speeds under an atmosphere of 160 °C was used as the birefringence film B, the polarizing plate was obtained in the substantially same manner as the experiment 1.

[0038] Comparison Example 6

Except for a point that a film which has $\Delta n_d : 20$ nm and the phase difference in a thickness direction of 350 nm and was obtained by making a polycarbonate film having a thickness of 60 μm subjected to a biaxial drawing treatment under an atmosphere of 160 °C was used as the birefringence film A, the polarizing plate was obtained in the substantially same manner as the experiment 1.

[0039] Evaluation Test

The polarizing plates (having wide viewing field) obtained by the experiments and the comparison examples were arranged at both sides (front/rear) of the TFT type liquid crystal cells and the viewing angle range in the left and right directions as well as in the upper and down directions which does not generate the deterioration of contrast and the inversion of gray scale due to black color blurring (blackening of display) or white color blurring (whitening of display) was

investigated.

[0040]

The result of the test was shown in a following table.

	Viewing angle range (degree)	
	Left and right directions	Upward and downward directions
Embodiment 1	160	40
Embodiment 2	160	70
Comparison example1	50	35
Comparison example2	60	30
Comparison example3	100	35
Comparison example4	40	25
Comparison example5	60	30
Comparison example6	80	45

[0041]

From the table, due to the comparison of the embodiments and the comparison example 1 which uses only the polarizing film, it is understood that the embodiments have remarkably improved the viewing angle range in the left and right directions and have slightly improved the viewing angle range in the upward and downward directions. Further, due to the comparison of the embodiments with the comparison examples 2 to 6, it is understood that the superposition of the layers which satisfies given birefringence characteristics is advantageous for enlarging the viewing angle range. The poor visibility in the embodiments and the comparison example 1 are brought about by the inversion of gray scale.

[Brief Explanation of the Drawings]

[Fig. 1] A partial cross-sectional perspective view of an example of a polarizing plate having wide viewing field.

[Fig. 2] A partial cross-sectional perspective view of another example of a polarizing plate having wide viewing field.

[Fig. 3] A cross-sectional view of an example of a liquid crystal display device.

[Fig. 4] A cross-sectional view of an example of other liquid crystal display device.

[Explanation of Symbols]

1: polarizing layer

2: adhesive agent layer

3: superposed birefringence layer

31: birefringence layer A

32: birefringence layer B

4: liquid crystal cell

[Abstract]

[Task] To obtain a polarizing layer which can enlarge a well-visible region in a liquid crystal display device.

[Means for solving the Task]

A polarizing plate with wide viewing field forming a birefringence layer A (31) having the phase difference in a thickness direction which is defined by a formula: $(n_s - n_z)d$ and is set to not more than 300 nm and the intra-plane phase difference which is defined by a formula: $(n_s - n_f)d$ and is set to not more than 20 nm and a birefringence layer B (32) having the intra-plane phase difference which is set to 50 to 200 nm and N_z which is defined by a formula: $(n_s - n_z) / (n_s - n_f)$ and is set to 0.8 to 3.5 on one side of a polarizing layer (1), wherein n_s indicates a refractive index in a lagging axis direction, n_f indicates a refractive index in a leading axis direction, n_z indicates a refractive index in a thickness direction and d indicates a layer thickness, and the lagging axis of the birefringence layer B and the transmission axis of the polarizing layer have either a relationship of being parallel to each other or a relationship of intersecting each other at a right angle.

[Effect]

The degrading of brightness and contrast in a front surface direction perpendicular to a surface of the polarizing layer can be prevented, the state change of linear polarized

light by the birefringence of a liquid crystal cell is compensated, a well-visible region which has no color change such as coloring and no gray scale inversion and is excellent in contrast and brightness can be enlarged and the liquid crystal display device having the wide viewing angle range can be obtained.